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Themes in Demand Response and Energy Efficiency

Prepared for the:
Arizona Corporation Commission
-- DSM Workshop --

Phoenix, Arizona

June 22, 2004

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Agenda

Sections:

1. Some themes and Views
2. Program Information -- Results and case studies

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Demand Response

1. Load response called for by others -- includes direct load control, partial or curtailable load reductions, and/or load interruptions.
   - Load response can help support the economics of Energy Efficiency (EE) and result in more (EE) being implemented
2. Price response -- includes response to real-time pricing, dynamic pricing, fixed time-differentiated rates (e.g., time-of-use rates), and demand bidding at different prices.
   - Pricing can make various types of (EE) and Demand Response (DR) economic for the customer.

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EE and DR Themes

1. Impact of competition in wholesale electric markets -- linking retail with wholesale markets seen as #1 problem in some jurisdictions.
2. A focus on overall electric market efficiency in response to higher fuel costs.
3. Lack of financing for any future (3 to 5 years) merchant plants.
4. Boom-bust cycle in competitive capital intensive commodity markets.
5. Public good nature of demand response as a result of restructured markets (even if only wholesale markets restructured).
6. Allowing customers to share in the benefits of restructured markets (even if only wholesale markets restructured).
7. The demand-side resource continuum -- delivery and economics.
8. Incenting productivity and appropriate technology development.

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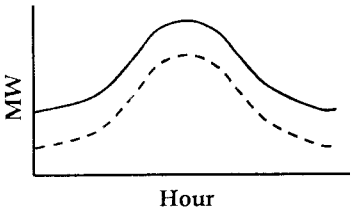
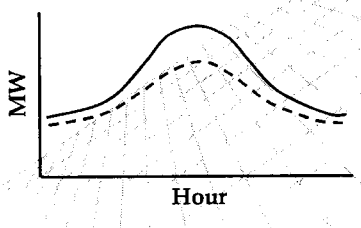
EE and DR Continuum

Perfect EE ---------- EE with DR ---------- Perfect DR Component

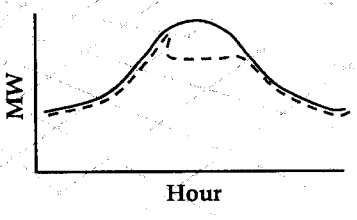
Load reduced by 1 MW at all hours



Load reduced by 1 at peak, and tapering off in non-peak hours



Load reduced in peak hours only



- Economics can be complementary and even favorable.
- Electricity markets need both types of impacts.

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EE and DR Continuum

Perfect EE ---------- EE with DR Component ---------- Perfect DR

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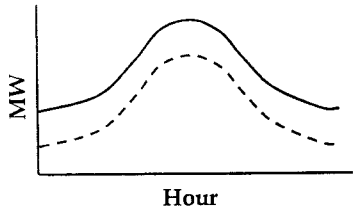
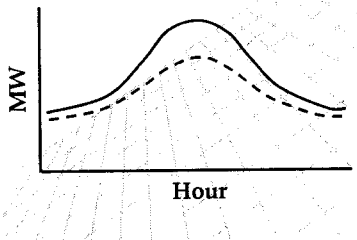
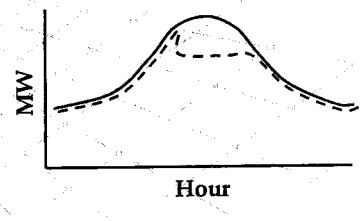


Load reduced by 1 at peak, and tapering off in non-peak hours



Load reduced in peak hours only



- Economics can be complementary and even favorable.
- Electricity markets need both types of impacts.

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EE and DR --A Portfolio View

- Conservation-based EE and critical-peak DR (looking at the extremes) both accomplish important objectives.
- Conservation EE:
  - Lowers demand in (most) all hours reducing base load plant use and can produce substantive environmental improvements due to the overall number of hours of reduced use of generation.
  - It is important to be cost-effective in energy use at all times, not just during peaks.
- Demand Response (DR):
  - The MW delta between the daily trough to daily peak remains the same, and on supra-peak days it can be difficult to provide enough "dispatchable load."
  - Pure DR provides dispatchable demand-side resources to meet supra-peaks complementing EE and supply-side resources (e.g., mitigates market power).

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Position: Is DSR a useful View?

- Demand-Side Resources (DSR) incorporates both EE and DR.
- Does this view make a difference?
  - We have a continuum of actions so where does one draw the line between DR and EE?
  - DR can make EE more cost-effective; and, vice versa.
  - EE measures not economic on their own can now make substantive economic contributions in combination with DR.
  - Reason: The monies gained by customers for infrequent response to very high prices can fund a lot of energy efficiency. (Think of any lighting program -- the economics are improved).

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Some Programmatic Examples

- Energy efficiency lighting:
  - Almost always reduces peak demand, but may not get full credit for helping manage peak, particularly on system peak days.
  - A DR component can incent new technology that reduces peak demand with increased value due to dispatchability (e.g., dimmable ballasts).
  - The value associated with the DR component can make the difference in a lighting project going forward or not going forward.
- New construction and major remodel programs:
  - Adding in dispatchable DR technologies can provide revenues to the customer to cover other investments.
  - As another example, SMUD building permits required all central AC units to be installed with a dispatchable switch (negligible cost).

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Wholesale Market Restructuring

- ONE POSITION: Initiatives that allow customers to respond to DR is important to the industry.
- WHY: 1) produces lower market clearing prices for all market participants; 2) reduces in supply-side market power; and 3) reduces price volatility.
- Wholesale electric markets have largely been de-regulated with market-based pricing for power producers.
- But, on the retail side, many utilities have grandfathered and/or eliminated load management and DR programs.
  - Expectation that competitive providers would step in with these offers.
  - Market and regulatory uncertainties made investment decisions by utilities difficult and bifurcation of benefits has reduced incentives.
  - Result -- a reduction in LM / DR over what existed in the 1990s.

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Market Efficiency Issues

- Is DR important to the continued development of efficient wholesale and retail markets?
- Issues:
  - Competitive markets are based on the interaction of supply and demand based on market signals -- we have wholesale competition.
  - However, the history of retail tariffs (pricing, EE and DR) is one of administered rates that, generally, do not account for costs that vary across hours, days and seasons.
  - Yet, wholesale electricity prices are among the most volatile of any commodity.
  - Result: A disconnect between retail and wholesale markets.
- BOTTOM LINE -- What is your view on electricity markets?
  - ONE VIEW: Markets should be designed/regulated to to allocate resources efficiently.

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Market Efficiency Questions

- *If we don't "manage or price what is scarce" (e.g., peak-period commodity):*
  - How do we incent demand-side innovation in programs and technology?
- *If we don't "manage or price what is scarce":*
  - How do we improve supply-side productivity in one of the country's most capital-intensive industries?
- Is it a short-term or long-term resource decision:
  - Is it a year-by-year decision; or,
  - Will developing an economic DR response capability will promote efficient resource investments over time.
- Estimating benefits of DR requires planning horizons longer than those commonly used, i.e., 5-yr and 10-yr plans.

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Managing what is Scarce

- POSITION: Technology innovation as an important category of benefits.
  - A newly rationalized electricity market can support business cases for innovation and new enabling technologies.
  - Technology companies have, and can, develop equipment that will allow customers to manage demand, while increasing overall comfort and providing other benefits.
  - The business cases for these technologies depend, in part, upon the dollar savings resulting from managing demand.
  - Appropriate DR reflecting what is costly and scarce will allow customers to be passive and still save money as technology develops -- i.e., technology companies will drive response.
  - New technologies, lower electric bills, more jobs, and new products all contribute to a stronger economy.

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Thinking through the Problem

- What rationale justifies not taking action?
- If there is a decision to take action -- How much DR is enough? After all, we only need to influence prices at the margins.
- Burden of proof:
  - Some industry stakeholders are simply believers in time-differentiated pricing based on the merits of the general arguments;
  - Others want to see estimates of the benefits.
- Estimating benefits -- Assessing DR programs requires that these program attributed be incorporated into company and industry planning models.

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Is it a Public Good/Regulatory Issue?

- Benefits from DR accrue to different entities:
  - Distribution companies in terms of deferred maintenance, deferred investment, and contingency avoidance.
  - Transmission owners through reduced capacity and maintenance.
  - Reliability managers (i.e., control areas and ISOs) through improved Loss of Load Probabilities (LOLPs).
  - Customers are able to receive payments/reduced costs for their ability to use electricity flexibly.
    - *A key attribute of consumption is now given a value.*
  - Technology companies now have a value proposition for innovation.
  - SO -- There are private values, but there are also market-wide values.
- DR Benefits are divided among private and public entities with no one entity willing to provide full value for DR.

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Estimating DR Benefits

1. Appropriately capturing the value associated with a pricing or DR resource option.
   - Many values associated with demand-side options are difficult to quantify.
   - But, they may be growing in importance as supply-side resources face more constraints and costs (e.g., transmission congestion, natural gas availability, and fuel prices)
   - Pricing and DR can be used as hedges against future extreme events.
2. Need to dimension uncertainty around future outcomes.
   - Simple planning paradigms such as 1 in 10 year events are not very useful in assessing option and hedge values as they only represent one point.
   - Different approaches are needed for dimensioning uncertainty if benefits are to be assessed.
   - There is a need to be able to work with distributions as inputs.

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DR "Offer" Values

- Values can include:
  - Increased system reliability through impacts at load centers, i.e.., the locational value of the resource.
  - Market benefits:
    - *Demand response can curb on supply-side reliance and market power.*
    - *Reduce prices throughout regional markets.*
    - *Promote efficient markets by demand and supply interaction.*
  - Flexibility --"real options" can address unexpected changes, e.g., lower growth rates in peak demand reduce time constraints on decisions.
  - Lowers hedging costs, i.e., costs of risk management by allowing customers to manage part of the price and quantity risks.
  - Produce environmental benefits by efficient use of resources.

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Portfolio Analyses and Planning

Today's planning environment requires analytics that:

- Uncertainty be addressed in the analyses.
- Identification and valuation of risk mitigation options.
- Credit benefits from both EE and DR for lower prices and risk management (i.e., hedging and options values).
  - Hedging values as expressed in reduced mean peak period prices and price volatility -- both influence forward price curves.
  - Direct price impacts in market transactions (gas and electric).
  - Other values (market power, innovation, customer values).
- Address the value of information and learning over time.
- Assess the value of flexibility, i.e., creation of real options to address future contingencies (some may not yet be known).
- Continue to appropriately analyze supply-side economics.

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Some Program Information

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CA Demand Response Goals

- PUC Rulemaking R.02-06-001 -- Advanced Metering, Demand Response and Dynamic Pricing:
  - Established Working Group 2 (WG-2) to design DR programs for customers with peaks greater than 200kW
  - From Decision D.03-06-032: the States' utilities "should rely upon demand response resources to serve load; and
  - Incentive rewards (and implied penalties) should be provided to utilities comparable to the return on investment in other physical plant projects.
  - Targets:

	Utility		
Year	PG&E	SCE	SDG&E
2003	150	150	30
2004	400	400	80
2005	3% of annual system peak demand		
2006	4% of annual system peak demand		
2007	5% of annual system peak demand		

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California WG2 -- DR Programs (200kW+ Customers)

- Programs: – Critical Peak Pricing (CPP), Demand Bidding Program (DBP), and Hourly Pricing Option (HPO):
  - CPP provides increased prices during critical peak periods and reduced prices during non-critical peak periods (PG&E CPP savings occur in summer only; SCE/SDG&E year-round)
  - DBP is a program that provides opportunities for customers to "bid-in" load reductions during critical periods for a "bid" incentive.
  - HPO is a daily adjusted hourly rate that provides potential cost savings for customers who can shift energy usage to lower-priced hours (only SDG&E).
- *Transitional Incentives* – Bill Protection Plan and Technical Assistance
- Other related programs:
  - CA Power Authority's Demand Reserves Partnership
  - CA Interruptible Programs

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ComEd/Chicago Cooperative ESPP DR Program

- The Energy Smart Pricing Plan (ESPP) program is one of the first large-scale residential Real Time Pricing (RTP) assessments in the United States.
- Questions addressed include:
  - Will residential customers respond to hourly market-based electricity prices?
  - What actions can and do residential customers take to respond to hourly prices?
  - What is the magnitude of the effect, i.e., to what degree can consumption be affected through the behavior and actions of small customers?
  - What are the characteristics of customers willing to participate in an RTP pricing plan?

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Energy-Smart Pricing Plan^{sm}

- This is a collaborative effort between:
  - Community Energy Cooperative (Cooperative),
  - Commonwealth Edison (ComEd), and the
  - Illinois Department of Commerce and Economic Opportunity (DECO).
- Objective: Test residential customers' responses to day-ahead, market based prices.
- DCEO provided funding for the interval meters, programmable thermostats and for this year-one assessment.
- The rate is not revenue neutral -- a price discount was offered due to the transfer of price risk from ComEd to the customer.

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Energy-Smart Pricing Plan[sm] (cont.)

- Started in January 2003, this program uses hourly energy pricing information provided through ComEd.
- Based on historical prices, participants could be expected to save about 10% off their current electric costs.
- The ESPP is available to any ComEd customer willing to join the Cooperative.
- But, initial marketing of the ESPP was targeted to Cooperative members and selected neighborhoods.
- Importantly, about half of the program's participants are new Cooperative members, reflecting a message that went beyond current members.
- In 2003, 750 customers were enrolled in the program.

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ESPP Elements

- Day-ahead pricing with participants given the next day's prices for each hour.
- Customers are informed by:
  - Accessing the Cooperative's website, or
  - Calling a toll-free number.
- High price notification -- whenever the next day's price went above 10¢ in an hour, participants were notified via e-mail or a phone call (generally between 7:00 and 10:00 PM).
- Participants received a price protection cap of 50¢ per kWh.
- AND, participants received energy management information from the Cooperative.

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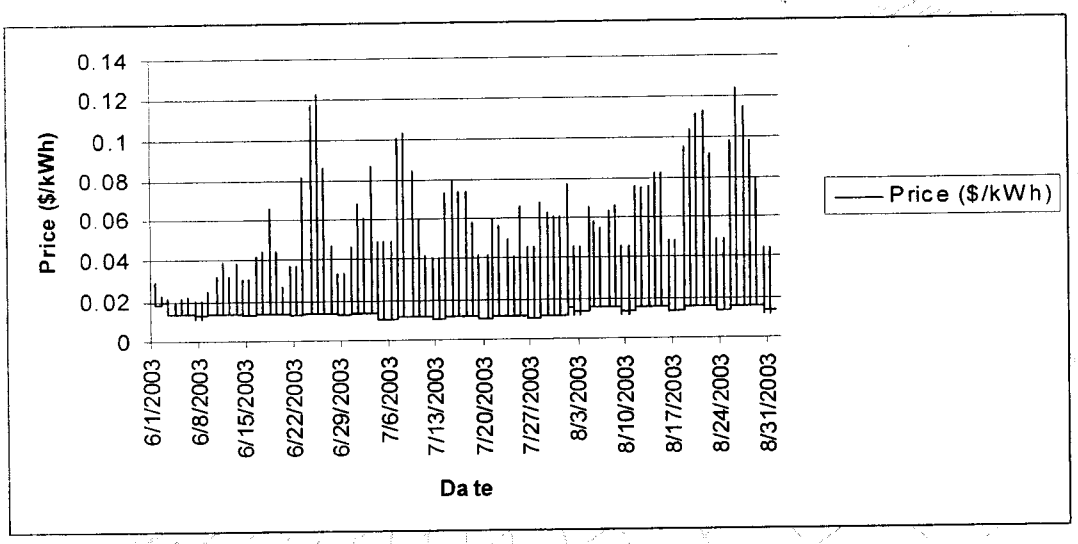
2003 Hourly Prices



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ESPP Findings

1. Residents responded to peak-period prices:

- Over half of all participants showing significant response to high price notifications (prices over 10 cents per kWh).
- Approximately a 25% reduction in peak was attained.
- This response tapers off both (1) over the length of the high price period, and (2) as the number of successive days of notifications increase.
- Across all hours, the estimated elasticity is .042 -- a 100% increase in the hourly price of electricity would result in a 4.2% decrease in electricity demand.
- Adjustments in conventional wisdom:
  - *This project showed that low-income and multi-family dwellings can fall into the "high responder" group.*

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ESPP Findings (cont.)

- Energy conservation was widely reported via survey responses.
- Multifamily units as a group were more responsive than single family homes, even in absolute kW.
- Single family homes with central air initially decreased demand, but this effect tapered off substantially in hours 3 and 4 during a multi-hour "high-price" event.
  - Could be due to 1) income effects, 2) behavior, 3) technology, and/or 4) building thermodynamics;
  - But program design, information and technology can probably help sustain the savings.
  - Further investigation is being undertaken.

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ESPP Findings (cont.)

- Over 80% of participants changed their AC use:
  - *20% reported using ACs less during high-price periods and more during low-price periods (i.e., pre-cooling).*
  - *20% simply reduced use during high-price periods.*
  - *60% reported that they reduced use whenever they could.*
    - Implies a conservation impact not accounted for in the model.
- Approximately 70% of participants who had clothes washers indicated they changed their pattern of use.
  - *Over half reported shifting washing to low-price periods.*
  - *Others indicated they lowered overall washer/dryer use.*

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Actions by ESPP Customers

1) Adjust AC use

2) Shift clothes washing/drying times.

3) Turn off lights more.

4) Use fans more.

5) Close blinds/shades during day.

6) Spend more time in coolest rooms

7) Install insulation or weather stripping.

8) Various other actions.

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ESPP Findings (cont.)

2. Customers liked the program:

- High satisfaction with 98% renewal after one year.
- Information from and interactions were favorable.
- Participants satisfied with savings -- ave. $12.00+/mo.
- Participants cited the following:
  - *They liked the partnership between the Cooperative and ComEd.*
  - *The ability to check on prices.*
  - *More control over electric bills.*
  - *Belief that they are part of the solution.*
  - *Program made them think about their energy-using habits.*
  - *Helps keep them informed.*
  - *"Convenient, affordable, reliable and effective."*

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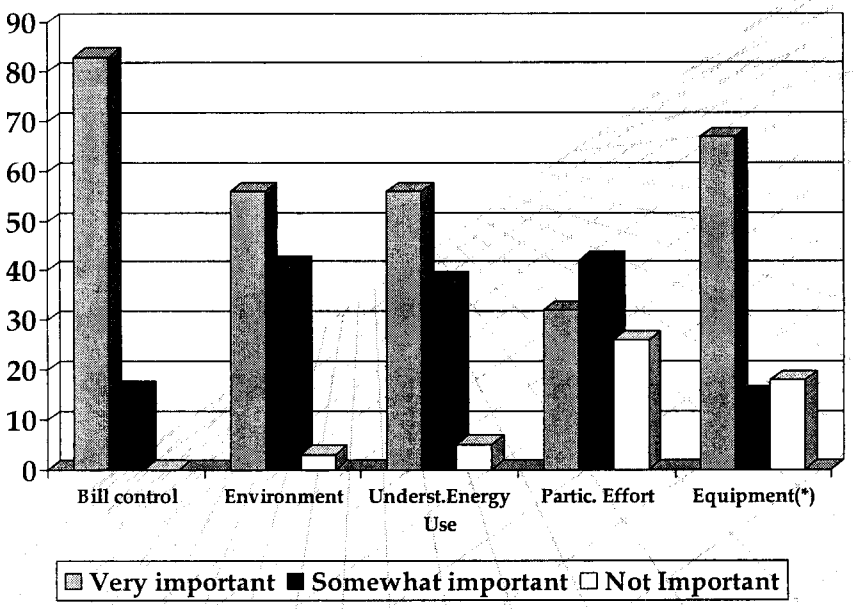
Importance of Program Benefits

Survey also shows "control" is <u>most</u> important for 77%...



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ESPP Future Research

- Verify results into its next two years.
  - Do participants continue to be responsive?
  - Are there observable characteristics of non-responsive customers that might help marketing?
- Quantify benefits at scale and at the system level.
- Determine how to adjust ComEd system dispatch and planning to accommodate the DR offer "at scale."
- Determine how to better "guarantee peak" reductions, e.g., combine pricing with dispatch, e.g., control switches, for true emergency situations.

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Three AC Cycling Programs

- AC Cycling Programs from three utilities -- Sacramento Municipal Utility District, Louisville Gas & Electric, and Kentucky Utilities.
- Innovative verification now available:
  - Use of regression/statistical approaches that make full use of all available data.
  - Use of less-expensive measurement methods -- run-time meters vs. interval data recorders.
  - Use of procedures to calibrate results against a nested sample of interval recorders.
  - Explored changes in indoor air temperature, humidity, and rebound after control periods.

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Impact Estimates Run-Time vs. Interval Metered Data (KU & LG&E)

AC Impact Estimates Per Unit Based on Run-Time Data

Outdoor Temperature Bin	Impact Estimates (KW per AC Unit) Cycling Strategy					
	33%	40%	50%	66%	75%	100%
<90 F	0.56	0.66	0.80	0.94	1.07	1.44
90 <95 F	0.59	0.70	0.87	1.02	1.21	1.75
>95 F	0.60	0.73	0.91	1.07	1.35	2.04

AC Impact Estimates Per Unit Based on Interval Metered Data

Outdoor Temperature Bin	Impact Estimates (KW per AC Unit) Cycling Strategy					
	33%	40%	50%	66%	75%	100%
<90 F	0.45	0.55	0.68	0.90	1.03	1.37
90 <95 F	0.52	0.63	0.78	1.03	1.17	1.56
>95 F	0.56	0.68	0.85	1.12	1.28	1.70

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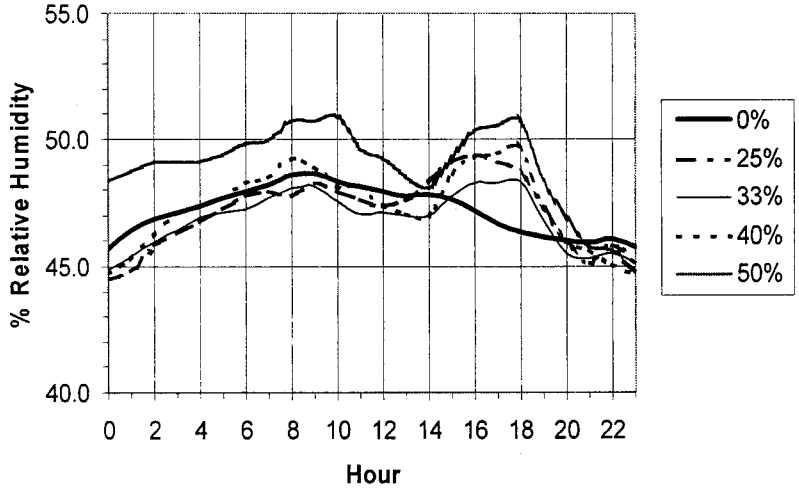
Impact of Control Strategies on Comfort

Table 8: Average Indoor Relative Humidity at Various Control Levels



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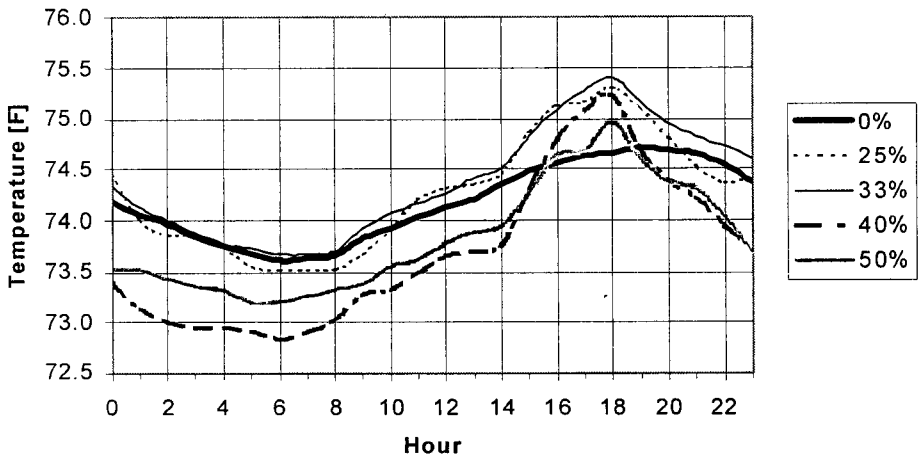
Impact of Control Strategies on Comfort

Table 9: Average Indoor Air Temperature at Various Control Levels



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Impacts by Control Strategy

Table 12. SMUD Impact Estimates

Outdoor Temperature Bin	Impact Estimates (kW per AC Unit)							
	Cycling Strategy							
	25%	33%	37%	50%	66%	75%	87%	100%
<=90F	0.46	0.60	0.68	0.91	1.21	1.37	1.59	1.83
91-95	0.49	0.64	0.72	0.98	1.29	1.46	1.70	1.95
96-100	0.54	0.71	0.80	1.08	1.43	1.62	1.88	2.17
101-105	0.60	0.80	0.89	1.21	1.59	1.81	2.10	2.42

- Target Marketing to weather sensitive customers can increase cost-effectiveness by 50% to 100%.
- The combination of intelligent cycling and "simple" target marketing can increase cost-effectiveness by 300% over basic AC programs holding program cost constant.

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Examples of Enrolled Participants & MW – Mass Market Programs

- BG&E - 300,000 participants; 350 MW
- ComEd - 68,000 participants; 80 MW
- FP&L - 600,000 participants; 700 MW
- FPC - 470,000 participants; 470 MW
- JCP&L - 62,000 participants: 62 MW
- SCE - 160,000 participants; 247 MW
- SMUD - 100,000 participants; 250 MW
- Xcel - 250,000 participants; 250 MW

Examples of Enrolled Participants & MW - C&I Programs

- Allegheny Power - 39 participants: 232 MW
- BG&E - 125 participants: 110 MW
- Cinergy - 280 participants: 600 MW
- ComEd - 160 participants: 160 MW
- Duquesne Light Company - 11 participants: 60 MW
- JCP&L - 51 participants: 44 MW
- NYSEG - 59 participants: 93 MW
- Portland G&E - 26 participants: 175 MW
- SCE - 168 participants: 244 MW
- Xcel (Minnesota) - 2000 participants: 500 MW
  (See Case Study at end of Slides)

Summary

- EE and DR are complementary to varying extents depending on the measures involved.
- BUT, there are budgets and not all things can be accomplished within a fixed budget.
- As a result, tradeoffs may be required and a decision to focus on select efforts in the EE / DR continuum may be made.
- HOWEVER, both EE and DR are important and the role of DR has changed as wholesale markets have deregulated.
- INTEGRATED EE / DR PLANS:
  - Can attain a lot of DR with small increases in program costs;
  - AND, for a constant budget, overall cost-effectiveness of DSM can be increased by focusing on high payoff DR integrated within current EE programs.

Case Study: Xcel Energy/NSP Interruptible Rates Program
Prepared by: Mr. Randy Gunn (former NSP Manager);
Summit Blue Consulting, April 2004 -- (PAGE 1 OF 3)

Program History

Northern States Power Company (NSP), now part of Xcel Energy, first started offering interruptible rates to its largest commercial and industrial customers in 1967. Through the interruptible rate program, the company offered discounts on demand charges to customers able to reduce their demand by one megawatt or more during peak periods. During the first 15 years or so of the program, NSP required customers to allow NSP to install a control switch on the equipment that the customer would shut off during peak periods that the utility could activate from its control room. Only a few customers were signed up for this early program, with about 50 MW of load reduction involved.

In the early 1980s, NSP desired to increase customer participation in the programs, and loosened many of the most restrictive program requirements. Changes that were made included:

- Customers were allowed to control their own load reductions instead of NSP doing so. The program changed to use contracts with customers which require them to reduce their loads to a pre-determined load level (PDL) during peak periods. Two rates were offered that correspond to two supply alternatives that would be deferred as a result of the program, a Peak-controlled rate (reflecting peaking units that would be deferred) and an Energy-controlled rate (reflecting deferral of oil-fired generation).
- The minimum demand reduction required of customers to participate in the program was reduced in stages, eventually going down to 50 kW of controllable load.
- NSP committed to provide the customers with a minimum of one hour notice before a control period, and tried to provide at least two hours of notice when possible.

Case Study: Xcel Energy/NSP Interruptible Rates Program
Prepared by: Mr. Randy Gunn (former NSP Manager);
Summit Blue Consulting, April 2004 -- (PAGE 2 OF 3)

- The program changed to Peak Controlled Rates and Energy Controlled Rates at that time.
- Through these program design changes and with considerable, ongoing program marketing through field sales personnel and supported by marketing department program and technical staff, Xcel Energy now has over 2,000 customers participating in this program, who provide over 500 MW of peak demand reduction during peak periods.

Program Purpose and Benefits

The purposes of these programs are to prevent potential power outages during systems peak periods and emergencies, and to serve customers' energy needs at the lowest possible cost. Xcel Energy conducts benefit-cost analysis for this program primarily by comparing the total program costs to the costs of building and operating peaking combustion turbines. The program is quite cost effective when evaluated on that basis.

Customer Recruitment Practices

Xcel Energy primarily recruits customers to participate in the programs though its account representatives. The account reps work with customers to determine the specific loads that customers could reduce during a peak demand period. In addition to that method, the utility has used direct mail, customer seminars, rate comparisons, and telemarketing to recruit customers to participate in the program. These efforts often require long lead times because of the need to address real and perceived business operations risks associated with managing the affected loads. Account reps work with customer staff to identify and assess appropriate loads to manage, and then work with the customer decision making process to get the potential load management effort budgeted and incorporated into the customer's business process. The process can take from months to years to work through before a customer agrees to participate.

Program Contracts

NSP/Xcel Energy has used program contracts with participating customers for over 20 years for this program. The minimum contract term is five years, and customers who opt to drop out before the end of their contract period are required to pay NSP/Xcel Energy back for the rate discounts that they previously received through the program. The contracts also specify the rate discounts that customers would receive as a result of participating in the programs, as well as penalties that customers would incur for not fully reducing their loads to the required PDL. The program's success has depended greatly upon the "carrot and stick" contract approach that involves both a significant incentive for successful load reduction and a penalty for failure to reach the PDL. The penalty importantly includes a waiver process in cases where there is some dispute over the load reduction, so that customers have a quasi-judicial recourse for problems that arise in their attempt to manage loads.

Customer Notification Procedures

How NSP/Xcel Energy notifies customers of an impending control period has changed considerably over the years. Throughout most of the 1980s, the Company used manual telephone calls from its account reps to notify customers, supplemented by fax notices. In the late 1980s, the company started using an automated phone calling system to notify customers. In the mid to late 1990s, the company expanded its notification methods to include pagers and e-mail notification in addition to the automated phone calls and faxes.

END OF CASE STUDY

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